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XXII. *Observations on the Aphides of Linnaeus, by Dr. William Richardson, of Ripon, Yorkshire: Communicated by William Heberden, M. D. F.R.S.*

Read Mar. 14,
1771.

THE learned *Linnaeus* by his unwearied application having reduced the various productions of nature into one regular system, and clearly distinguished the numerous tribe of insects into their distinct classes and subdivisions, seems to me to have laid a more solid foundation for the natural history of these minute animals, than any other writer who has gone before him. Difficult, however, as it is to lay so firm a foundation, the superstructure must still be esteemed a more arduous undertaking; as it is easier to distinguish the outward form, even of the minutest insects, than to discover their internal nature and disposition. This is a knowledge not to be attained by any single person, be his genius and diligence ever so great; but to bring it to any degree of perfection, will require the joint endeavours of the curious in all ages, and in all the different parts of the world. From which considerations, I am induced to throw in my mite towards promoting so useful an undertaking; by reducing my observations on this surprizing kind of insect, into a more concise and regular form.

Though the Aphides are distinguished by Linnæus into more than thirty species; still I am satisfied, from my own observation, the distinct species are even double that number: nor can I altogether agree with this ingenious author, that there are a greater variety of plants producing Aphides, than there are different sorts of this insect. Where plants are of a like nature, they are usually frequented by the same insects; but many of these plants will be found to support two or more quite different sorts. On the peach and nectarine indeed the Aphides are the same, nor do I find on these trees more than one sort. The plum tree, on the other hand, has two sorts, very distinct from each other: one of a yellowish-green, with a round short body; the other of a bluish-green, as it were enameled with white, and the shape more oblong. On the gooseberry-bush and currant the same Aphides may be found; but each of these is inhabited by two very different species: one being of a dusky green, with a short plump body; the other of a paler green, the body more taper, and transversely wrinkled. To these instances I must further add, that the rose-tree supports not less than three distinct species: The largest of which is of a deep green, having long legs of a brownish cast, with the joints of a very dark brown, as are also the horns and antennæ; a second sort is paler green, has much shorter legs, and a more flat body; the third sort is of a pale red, its body transversely wrinkled, and is most frequently on the sweet-brier. It not being, however, so much my intention to enumerate the different species of these insects, as to give some insight into their extraordinary

nary nature; the instances I have already produced will, I flatter myself, be thought sufficient.

The great variety of species which occur in the insects now under consideration may indeed make an enquiry into their particular natures seem not a little intricate and perplexed; having them, however, skilfully reduced under their proper genus, the difficulty is by this means considerably diminished. All the insects comprehended under any distinct genus, we may reasonably suppose to partake of one general nature; and, by diligently examining any of the particular species, may thence gain some insight into the nature of all the rest. With this view I have chosen, out of the various sorts of Aphides, the largest of those found on the rose tree; not only as its size makes it the more conspicuous, but as there are few others of so long a duration. This sort, appearing early in the spring, continues late in the autumn; while several are limited to a much shorter term, in conformity to the different trees and plants from whence they drew their nourishment.

SECTION I.

If at the beginning of February the weather happens to be so warm, as to make the buds of the rose tree swell and appear green; small aphides are frequently to be found upon them, not larger than the young ones in summer, when first produced. But there being no old ones to be found at this time of the year, which in summer I had observed to be viviparous; I was formerly not a little perplexed by
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such different appearances, and almost induced to give credit to the old doctrine of equivocal generation. That the same kind of animal should, at one time of the year be viviparous, and at another oviparous, was an opinion I could then by no means entertain. This, however, frequent observation has at last convinced me to be fact; having found those Aphides, which appear early in the spring, to proceed from small black oval eggs, which were deposited on the last year's shoots in autumn: though, when it happens that those insects make too early an appearance, I have observed the greatest part to suffer from the sharp weather that usually succeeds; by which means the rose trees are some years in a manner freed from them.

Those which withstand the severity of the weather, seldom come to their full growth before the month of April; at which time they usually begin to breed, after twice casting off their exuviae, or outward-covering. It then appears that they are all females, which produce each of them a very numerous progeny, and that without having intercourse with any male insect. As I observed before, they are viviparous; and what is equally uncommon, the young ones all come into the world backwards. When they first come from the parent, they are enveloped by a thin membrane, having in this situation the appearance of an oval egg; which I apprehend must have induced Reaumur to suspect that the eggs discovered by Bennet were nothing more than abortions. This egg-like appearance adheres by one extremity to the mother, while the young one therein contained extends the other; by that

means gradually drawing the ruptured membrane, over the head and body, to the hind feet. During this operation, and for some time after, by means of something glutinous, the fore part of the head adheres to the vent of the parent. Being thus suspended in the air, it soon frees itself from the membrane in which it was confined, and after its limbs are a little strengthened, is set down on some tender shoot, and then left to provide for itself.

When the spring proves mild, and consequently favourable to this kind of insect, I have observed not only the rose trees, but various kinds of fruit-trees, to be greatly injured by them. Hence I was first introduced to investigate the nature of these insects; in order to find out some expedient, whereby so great an evil might be prevented. To avoid being tedious by descending to particulars, I shall recommend the following general rule; *viz.* to lop off the infected shoots before these insects are greatly multiplied; repeating the same operation before the time their eggs are deposited. By the first pruning, you will prevent a very numerous present increase; and by the second, may intirely cut off the next year's supply.

SECTION II.

In the spring months, there appear on the rose tree but two generations of Aphides, including those which immediately proceed from the last year's eggs; the warmth of the summer adds so much to their fertility, that no less than five generations succeed each other during that interval. One is produced

duced in May, which twice casts off its covering; while the months of June and July each supply two more, which cast off their coverings three or four times, according to the different warmth of the season. This frequent change of the outward covering is the more extraordinary, as it is the ofteneft repeated when the insects come the soonest to their growth; which I have sometimes observed to happen in ten days, where warmth and plenty of nourishment have mutually conspired. From which considerations, I am thoroughly convinced, that these various coverings are not connate with the insect; but that they are like, the scarf-skin, successively produced.

Early in the month of June, some of the third generation, which were produced about the middle of May, after casting off their last covering, discover four erect wings, much longer than their bodies: and the same is observable in all the succeeding generations, which are produced during the summer months; without however distinguishing any diversity of sex, as is usual in several other kinds of insects. For some time before the Aphides come to their full growth, it is easy to discover which of them will have wings, by a remarkable fulness in the breast, which in the others is hardly to be distinguished from the body. When the last covering is rejected, the wings, which were before folded up in a very narrow compass, gradually extend themselves in a most surprizing manner, till their dimensions are at last very considerable. But these winged ones have this further peculiarity, that the number of them does not seem so much to depend on their

original structure, as on the quantity or quality of the nourishment wherewith they are supplied: it being frequently observable, that those on a succulent shoot have few or none with wings among them; while others of the same generation, on a less tender branch, are most of them winged: as if the first rudiments of the wings were composed in the former, while nature thought proper to expand them in the latter, that they might be more at liberty to supply their wants.

The increase of these insects in the summer time is so very great, that, by wounding and exhausting the tender shoots, they would frequently suppress all vegetation, had they not many enemies which restrain them. To enumerate the variety of other insects, that in their worm and fly state are constantly destroying them, would exceed the bounds of my present design: there is one, however, so singular in the manner of executing its purpose, that I cannot pass it by without some further notice. This is a very small black ichneumon fly, with a slender body, and very long antennæ; which darts its pointed tail into the bodies of the Aphides, at the same time depositing an egg in each. This egg produces a worm, which feeds upon the containing insect, till it has acquired its full growth; when it is usually changed to that kind of fly from whence it had its origin. In this, however, it is sometimes prevented by another sort of small black fly, which wounds this worm through its pearl-like habitation; and by laying one of its eggs therein, instead of the former fly, produces its own likeness.

I must however further observe, notwithstanding these insects have many enemies, they are not without friends ; if we may consider those as such, who are very officious in their attendance, for the good things they expect to reap thereby. The ant and the bee are both of this kind, collecting the honey in which the Aphides abound ; but with this difference, that the ants are constant visitors, the bee only when flowers are scarce. To which let me also add, that the ants will suck in the delicious nectar, while the Aphides are in the act of discharging it from the anus ; but the bees only collect it from the leaves, on which this honey-dew has fallen.

S E C T I O N III.

In the autumn, I find three more generations of Aphides to be produced ; two of which make their appearance in the month of August, and the third usually before the middle of September. As the two first differ in no respect from those which we meet with in summer, it would be wasting time to dwell any longer upon them ; but the third, differing greatly from all the rest, demands our giving it a more serious attention. Though all the Aphides which have hitherto appeared were females, in this tenth generation are found several male insects ; not that they are by any means so numerous as the females, being only produced by a small part of the former generation. To which I must further add, that I have observed those which produce males, previously to have produced a number of females ; which in all respects resembling those already described,

scribed, I shall decline taking into any further consideration.

The females have at first altogether the same appearance with those of the former generations; but in a few days their colour changes from a green to a yellow, which is gradually converted into an orange-colour, before they come to their full growth. They differ likewise in another respect, at least from those which occur in the summer, that all those yellow females are without wings. The male insects are however still more remarkable; their outward appearance readily distinguishing them, from the females of this and all other generations. When first produced, they are not of a green colour like the rest, but of a reddish brown; and have afterwards, when they begin to thicken about the breast, a dark line along the middle of the back. These male insects come to their full growth in about three weeks time, and then cast off their last covering; the whole insect being after this operation of a bright yellow, the wings only excepted. But they soon change to a darker yellow, and in a few hours to a very dark brown; if we except the body, which is something lighter coloured, and has a reddish cast. They are all of the winged sort; and the wings, which are white at first, soon become transparent, and at length appear like very fine black gauze.

The males no sooner come to maturity, than they copulate with the females; in which act they are readily discovered, as they remain in conjunction for a considerable time, and are not easily disturbed. The commerce between them continues the whole month of October, and may be observed at all times
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of the day; though I have found it most frequent about noon, especially when the weather is moderately warm, with the sun overcast. The females, in a day or two after their intercourse with the males, I have observed to lay their eggs; which they usually do near the buds, when they are left to their own choice. Where there are a number crowded together, they of course interfere with each other; in which case, they will frequently deposit their eggs on other parts of the branches, or even on the spines with which they are beset. I do not however find that the eggs produced by these insects bear any proportion to the number of young ones which proceed from the females of other generations; not having observed any one insect to produce more than two or three, and that in appearance with great difficulty.

Having now traced their progress through the different seasons of the year, and observed the various metamorphoses which they successively undergo; I cannot help suspecting the insufficiency of human reason, in setting any scheme to which the different changes of insects may be accurately reduced. Though the indefatigable Swammerdam seems to have been fully convinced that there is no insect, whose changes may not be reduced to one or other of the four orders he has described; still the insect now under consideration, having at different seasons quite different appearances, cannot, I think, with strictness be confined to any of them. In the spring they seem in some measure to coincide with the first order, though in summer those with wings more properly belong to the second; but in
autumn,

autumn, the males may seem to come under one order, and the females under another; or, I should rather think these insects are not clearly reducible to any order.

S E C T I O N I V.

Some of the insects now under consideration continuing to lay their eggs till the beginning of November, I choose to defer giving a more particular account of them, till the season for which they seem by nature to have been designed. These eggs are of a regular oval figure, being about the tenth part of an inch in length, and the twentieth in breadth; which, though it may seem a very inconsiderable bulk, is certainly large for so minute an insect. When they are first produced, their colour is green, but in a few days turns to brown, and by degrees becomes quite black. The covering of the eggs may be called thick, if compared with its small size; which at first is rather of a yielding nature; but, after being exposed to the air, soon contracts a greater firmness. If this covering is wounded, there issues forth a mucilaginous fluid, which is very transparent, and in appearance of a uniform consistence. These eggs adhere firmly to the branches on which they are deposited, by means of something glutinous wherewith they are besmeared, and in a most surprising manner resist all the severity of the winter.

Though I have just now observed, the contents of the eggs to have the appearance of an uniform fluid; that this cannot in reality be the case, sufficiently appears from the Aphides they produce in
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the spring, without any other aid than the warmth of the season. Nor is a single insect to be esteemed the whole product of an egg, since it has been clearly shewn, that ten generations succeed each other; the first rudiments of which must have been originally in the egg, as the females have no communication with the males but in autumn. The wonder however becomes still greater, when we consider the number of individuals in each generation; this being, I am fully convinced, at a medium, not less than fifty. Whoever pleases to multiply by fifty, nine times over, may by this means form some notion of the great number of insects produced from a single egg; but will at the same time find that number so immense, as to exceed all comprehension, and indeed to be little short of infinity. How far this can be reconciled with any theory of generation which the ingenuity of man has hitherto invented, may be a contemplation not altogether unworthy our curiosity, though I fear it will not turn out much to the credit of our reasoning faculties.

The ancient doctrine of equivocal generation, as also that from an admixtion of the seminal matter of both sexes, being now quite rejected by all modern naturalists; two other opinions seem to have sprung up in their stead. While one party asserts, that the original organization of the foetus exists in the ovary of the female, and that it is vivified by a subtle spirit in the spermatic fluid of the male; the other lays it down for a certainty, that the eggs of the female are only to be considered as a proper nidus, provided for the reception of those minute animalcules, with which the male semen is found to

abound. As the former opinion does not appear to have any certain fact to support it, we may well suspect an insufficiency in the cause to produce the effect assigned; but, supposing it adequate to the production of one generation, who can conceive a subtile spirit to remain in force for ten generations, and that through all the various seasons of the year? With regard to the latter, I must observe, that the animalcules of Leeuwenhock being compared with Malpighi's first rudiments of the chick, their resemblance is not so striking as to afford me the least conviction: but should we allow these animalcules requisite to produce the first generation, how then are the subsequent nine generations produced without them? Not being able to answer these queries myself, nor expecting them to be readily answered by others; it seems most prudent to observe with diligence what nature does, without being over anxious to discover by what means. Let us rest satisfied in admiring the wonderful effects of generation, while we refer the primary efficient cause to the eternal will and power of an Almighty Creator.